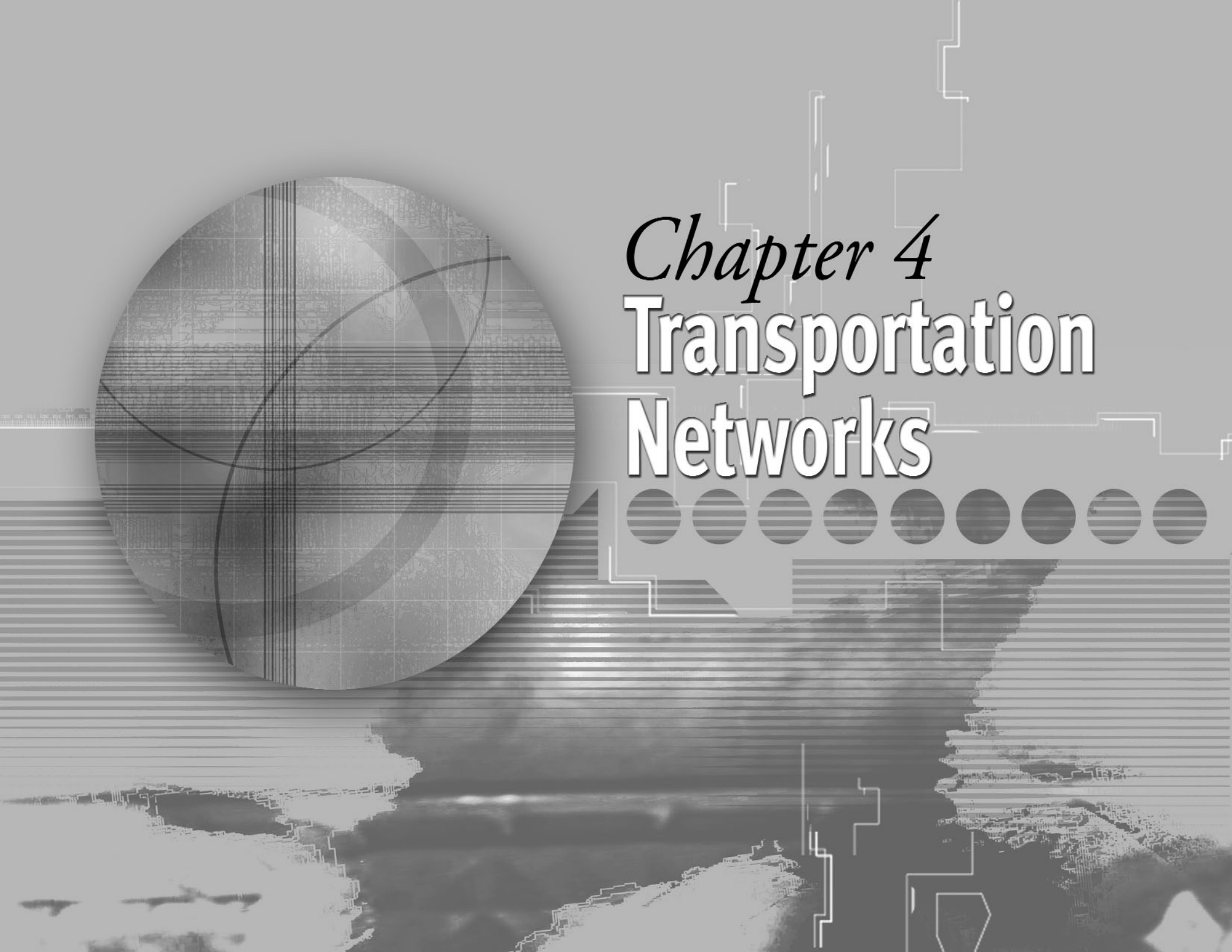
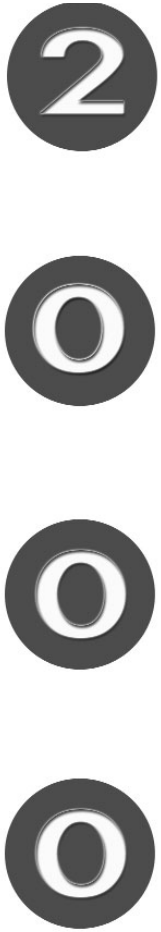


Chapter 4
Transportation Networks

Transportation Networks

Chapter 4



Introduction

The Year 2000 Model uses an integrated transportation network (highway, street, and transit systems). The zonal system and the modeling area are described in Chapter 1. This Chapter summarizes the highway, transit, toll, and heavy-duty truck networks used in the Year 2000 Model Validation.

For the highway network, links by facility type (i.e.: freeways, expressways, arterials, etc.) and area type (i.e.: central business district, urban area, etc.) are determined based on SCAG's Highway Inventory. The network attributes were updated to Year 2000 conditions and distributed to Caltrans and the sub-regional modeling agencies for review and comment. The freeflow speed and roadway capacity used by trip distribution and assignment were assigned to the network using speed/capacity lookup tables (see Tables 4-1 through 4-5). A summary of the number of links, roadway centerline miles, and number of lane miles in the highway network is provided (see Table 4-6). This information is summarized by county and for the Region as a whole. The four model time periods are defined later in this Chapter.

The transit network is a key input to the mode choice model and is used in the transit trip assignment process. For the transit network, all elements that are used to determine "level of service" for the mode choice calculations are identified and defined in this Chapter. The various modes (Metrolink, MTA local bus, etc.) in the transit network are also identified. Finally, a summary of the number of transit lines, route miles, and vehicle miles and hours of service represented in the regional transit network, by mode, is presented (see Table 4-7).

Highway Networks

The Regional highway network includes the following components:

- A **"mixed flow"** highway network or facilities that allow general purpose trips
- A **"shared ride"** (vehicles with 2 or more persons) High Occupancy Vehicle (HOV) network
- A **"carpool"** (vehicles with 3 or more persons) network
- A **"toll"** road network
- A **"heavy-duty truck"** network

These networks were developed for each of the following four modeling time periods:

- **"A.M."** peak period (6:00 A.M. to 9:00 A.M.)
- **"P.M."** peak period (3:00 P.M. to 7:00 P.M.)
- **"Midday"** period (9:00 A.M. to 3:00 P.M.)
- **"Night"** period (7:00 P.M. to 6:00 A.M.)

The highway network was developed and coded utilizing a commercial Geographic Information System (GIS) network file and an extensive street inventory survey. Use of the GIS network base will enable future network additions or modifications to be made more accurately.

A highway network is defined by nodes (beginning and ending points of a highway segment) and links (highway segment) files. In other words, a link represents a segment of a roadway and a node typically represents the intersection of two roads. The node file contains node

Transportation Networks

- **Integrated Networks – All transportation networks share a common base map.**
- **spatial Location - the net - works are built directly from the commercial digital base map resulting in spatially correct networks.**
- **Enhanced Network Detail – The network includes a more realistic representation of the freeway system. The networks also include substantially more of the minor arterial and major collector system.**
- **Highway Attributes – Year 2000 network attributes were obtained from SCAG's Highway Inventory.**
- **Transit Attributes – Accurate year 2000 transit attributes were obtained from transit operators.**

coordinates (or spatial location data) needed for plotting and air quality analysis purposes. Each link is characterized by attributes such as distance, facility type, area type, capacity, number of lanes, observed speed (or time), free flow speed (or time), and geographic location. Free-flow speeds are assigned to the network considering the posted speed and area type coded for each link (see Appendix C for a description of the network coding conventions).

Facility Types ("FT") used in the Year 2000 highway networks are as follows:

Facility Types:

- **FT 0** Connectors between HOV lanes and mixed-flow lanes
- **FT 1** Freeways (mixed flow lanes)
- **FT 2** Principal Arterials
- **FT 3** Minor Arterials
- **FT 4** Major Collectors
- **FT 5** HOV: a carpool facility for two or more persons per vehicle
- **FT 6** Centroid Connectors
- **FT 7** Freeway Ramps
- **FT 8** Freeway-Freeway Connector
- **FT 9** Toll Links: segments along a toll facility

Area Types (AT) used in the highway networks were prepared based on development density (population and employment density) and land use characteristics.

Area Types:

- **AT 1** Core
- **AT 2** Central Business District
- **AT 3** Urban Business District
- **AT 4** Urban
- **AT 5** Suburban
- **AT 6** Rural
- **AT 7** Mountain

Free-flow speeds and capacities assigned to each link in the network are arrayed in Table 4-1 through Table 4-5 considering the posted speed, facility type and area type of each link. Free-flow speeds are same in both the peak and off-peak networks for the purpose of vehicle trip assignment.

"Observed speed" values, which fall between 75 and 85 percent of free-flow speeds, were assigned to links in the peak and off-peak networks for the initial model run, but only through mode choice. After the first pass through the assignment process, the model networks were revised to reflect model-estimated "congested" speeds, thereby replacing observed speeds. The congested speeds were then used to recreate the transit network which were then 'fed back' to trip generation model for a second pass through trip distribution, mode choice, and assignment. This process is repeated until the total Vehicle Miles Traveled (VMT) estimated by the Model is within 1 percent of the proceeding iteration's VMT.

Table 4-1

FREEWAY/EXPRESSWAY FREE FLOW SPEED

	AT1	AT2	AT3	AT4	AT5	AT6	AT7
Freeway / HOV	60	62	62	65	65	70	65
Expressway	PS	PS	PS	PS+5	PS+5	PS+5	PS+5
Fwy-Fwy Connector	45	45	50	50	55	55	55
On-Ramp (peak)	15	15	20	20	30	35	35
On-Ramp (off-peak)	25	25	30	30	35	35	35
Off-Ramp	25	25	30	30	35	35	35

Notes: PS = Posted Speed
AT 1: Core
AT 2: Central Business District
AT 3: Urban Business District
AT 4: Urban
AT 5: Suburban
AT 6: Rural
AT 7: Mountain

Table 4-2

ARTERIAL FREE FLOW SPEED

Posted Speed	Principal Arterial						
	AT1	AT2	AT3	AT 4	AT5	AT6	AT7
20	21	22	22	24	25	27	27
25	23	24	25	27	28	31	31
30	25	26	27	29	31	34	34
35	27	28	29	32	35	38	38
40	28	30	32	34	37	41	41
45	30	32	34	37	40	45	45
50	33	35	37	41	45	51	51
55	34	38	39	44	49	56	56
	Minor Arterial						
20	19	20	21	23	24	27	27
25	21	22	23	25	27	30	30
30	22	24	25	28	30	34	34
35	24	26	27	30	33	37	37
40	25	28	29	32	36	41	41
45	27	29	31	34	38	44	44
50	29	32	33	38	43	50	50
55	30	33	35	40	46	55	55
	Major Collector						
20	17	18	19	21	23	26	26
25	18	20	21	23	26	30	30
30	19	21	22	25	28	33	33
35	20	22	24	27	31	36	36
40	21	24	25	28	33	39	39
45	22	25	26	30	35	43	43
50	23	27	28	33	39	48	48
55	24	28	30	35	42	52	52

Notes: Add 4% for divided streets.
AT 1: Core
AT 2: Central Business District
AT 3: Urban Business District
AT 4: Urban
AT5: Suburban
AT 6: Rural
AT 7: Mountain

Table 4-6 summarizes the Year 2000 Highway Network. The network summary is accomplished by tallying the number of highway facility route and lane-miles represented in the network, for each county and facility type. The route mile summary (see Table 4-6) includes both directions of travel, even if the section of roadway is represented by two separate one-way links in the coded network.

Transit Networks

The updated Year 2000 transit network incorporates a total of 12 transit "modes" and 8 different types of "transit access links" representing various forms of transfers, connectors, or access/egress links.

Table 4-3

ARTERIAL/EXPRESSWAY CAPACITY* (Signal Spacing ‹ 2 mi)

On\Crossing	AT1 Core 2-lane	4-lane	6-lane	8-lane
2-lane	475	425	375	375
4-lane	650	600	500	500
6-lane	825	700	600	550
8-lane	825	700	650	600
	AT2 Central Business District			
2-lane	500	450	400	400
4-lane	675	625	500	500
6-lane	850	725	625	575
8-lane	850	725	675	625
	AT3 Urban Business District			
2-lane	525	450	400	400
4-lane	700	625	525	525
6-lane	875	750	650	600
8-lane	875	750	700	650
	AT4 Urban			
2-lane	550	475	425	425
4-lane	750	675	550	550
6-lane	925	800	675	625
8-lane	925	800	750	675
	AT5 Suburban			
2-lane	575	500	425	425
4-lane	750	675	550	550
6-lane	925	800	700	625
8-lane	925	800	750	700
	AT6 Rural			
2-lane	575	500	425	425
4-lane	750	675	550	550
6-lane	925	800	700	625
8-lane	925	800	750	700
	AT7 Mountain			
2-lane	575	500	425	425
4-lane	750	675	550	550
6-lane	925	800	700	625
8-lane	925	800	750	700

Notes: Capacities are in pcplph.
Lanes are mid-block 2-way lanes.
Add 20% for one-way streets.
Add 5% for divided streets.

Table 4-4

ARTERIAL/EXPRESSWAY CAPACITY (Signal Spacing ›=2 mi)

Multilane Highway	Posted Speed	Capacity (per lane)
	45	1,800
	50	1,900
	55	2,000
	60	2,100
2-Lane Highway		1,400

Table 4-5

FREEWAY CAPACITY

	AT1	AT2	AT3	AT4	AT5	AT6	AT7
Freeway / HOV (pcplph)	2,100	2,100	2,100	2,100	2,100	2,100	2,100
Fwy-Fwy Connector (pcplph)	2,000	2,000	2,000	2,000	2,000	2,000	2,000
On-Ramp (first lane)	720	720	720	720	1,400	1,400	1,400
On-Ramp (additional lane)	480	480	480	480	600	1,400	1,400
On-Ramp (off-peak)	1,300	1,300	1,300	1,300	1,400	1,400	1,400

Notes: Use arterial/expressway capacity estimation procedure for Off-ramps.
AT 1: Core
AT 2: Central Business District
AT 3: Urban Business District
AT 4: Urban
AT 5: Suburban
AT 6: Rural
AT 7: Mountain

Table 4-6

YEAR 2000 HIGHWAY NETWORK SUMMARY

	County					
	LOS ANGELES	ORANGE	RIVERSIDE	SAN BERNARDINO	VENTURA	TOTAL REGION
FREEWAY: (Facility Type 1)						
Route Miles	531	202	221	189	93	1,236
Lane Miles	4,265	1,433	1,320	1,135	514	8,667
PRINCIPAL ARTERIAL: (Type 2)						
Route Miles	2,096	632	308	529	253	3,818
Lane Miles	8,390	3,235	1,227	1,797	927	15,576
MINOR ARTERIAL: (Type 3)						
Route Miles	2,614	784	887	1,250	327	5,862
Lane Miles	8,498	2,943	2,754	3,556	953	18,704
MAJOR COLLECTOR: (Type 4)						
Route Miles	961	94	1,061	1,076	73	3,265
Lane Miles	2,245	303	2,684	2,765	219	8,216
HOV 2: (Facility Type 5)						
Route Miles	170	98	18	26	1	313
Lane Miles	349	201	39	52	2	643
HOV 3+: (Facility Type 8)						
Route Miles	10	-	-	-	-	10
Lane Miles	21	-	-	-	-	21
TOTALS:						
Route Miles	6,382	1,810	2,495	3,070	747	14,504
Lane Miles	23,768	8,115	8,024	9,305	2,615	51,827

Note:
One route mile in this table represents a pair of opposite-direction links covering one mile.

Transit Modes

The twelve transit "modes" are as follows:

Mode 10: Metrolink Rail

Mode 11: MTA Local Bus

Mode 12: MTA Express Bus

Mode 13: Urban Rail (MTA Metrorail)

Mode 14: LA County Express Bus includes express bus service provided in Los Angeles County by non-MTA providers such as:
- Foothill Transit
- Los Angeles Department of Transportation (DOT)
- Santa Monica Municipal Bus Lines
- Municipal Area Express – (MAX)

Mode 15: LA County Local Bus Service provided by:
- Antelope Valley Transit Authority
- Foothill Transit
- Montebello Bus Lines

Mode 16: LA County Local Bus Service provided by:
- Carson Circuit
- Culver City Bus
- Gardena Municipal Bus Lines
- Long Beach Transit
- Norwalk Transit
- Santa Clarita Transit
- Santa Monica Municipal Bus Lines
- Torrance Transit

Mode 17: LA County Local and Shuttle Bus Service provided by:
- Gardena
- Los Angeles DOT

Mode 18: LA County Local Bus Service provided by:
- Commerce Municipal Bus Lines
- Santa Fe Springs
- Inglewood

Mode 19: All Non-LA County Local Bus Service

Mode 20: All Non-LA County Express Bus Service

Mode 22: Rapid Bus Service

The Los Angeles County local bus lines (mode 14- 18) are grouped by similar fare structures. Transit fares are an important input variable to the mode choice model.

Transit Access

The eight types of "transit access links" used in the Year 2000 model transit network are identified as "Modes 1 through 8", and are defined as follows:

Mode 1 sidewalk transfer links provide a transfer connecton between transit stations and transit stops. these primarily consist of walk links in the downtown Central Business District (CBD) and around rail stations. this process enables more realistic modeling of walk transfers, both between bus and rail.

Mode 2: Auto access links are coded in the network as one-way links from a zone centroid (representing the center of land use activity within a TAZ) to a park-n-ride lot, where transit could be boarded.

Mode 3: Walk access links are coded in the network as one-way walk links from the zone centroid to the transit network.

Mode 4: Park-n-ride to transit links, are coded in the network as one-way walk links from a park-n-ride lot to a transit boarding location.

Mode 5: Walk egress links are coded in the network as one-way walk links from the transit line to the zone centroid.

Mode 6: Shuttle access links are coded in the network as one-way links from the zone centroid to the transit network.

Mode 7: Shuttle egress links are coded in the network as one-way links from the transit line to the zone centroid.

Mode 8: Free transfer links are coded in the network as two-way walk links between Metrolink and Metro Rail.

Separate transit networks were prepared to reflect "peak" (6:00 to 9:00 A.M.) and "off-peak" (midday: 9:00 A.M. to 3:00 P.M.) conditions in the Year 2000 Model. Table 4-7 summarizes the number of transit patterns/routes represented in the peak and off-peak transit networks, by "transit mode" as defined above.

Toll Network

The Year 2000 network includes toll facilities. Toll facilities include the SR-91 Express Lanes operated by the California Private Transportation Company (CPTC), and the San Joaquin Eastern and Foothill Toll Roads developed by the Transportation Corridor Agency (TCA). All toll facilities are located in Orange County.

Heavy-Duty Truck Network

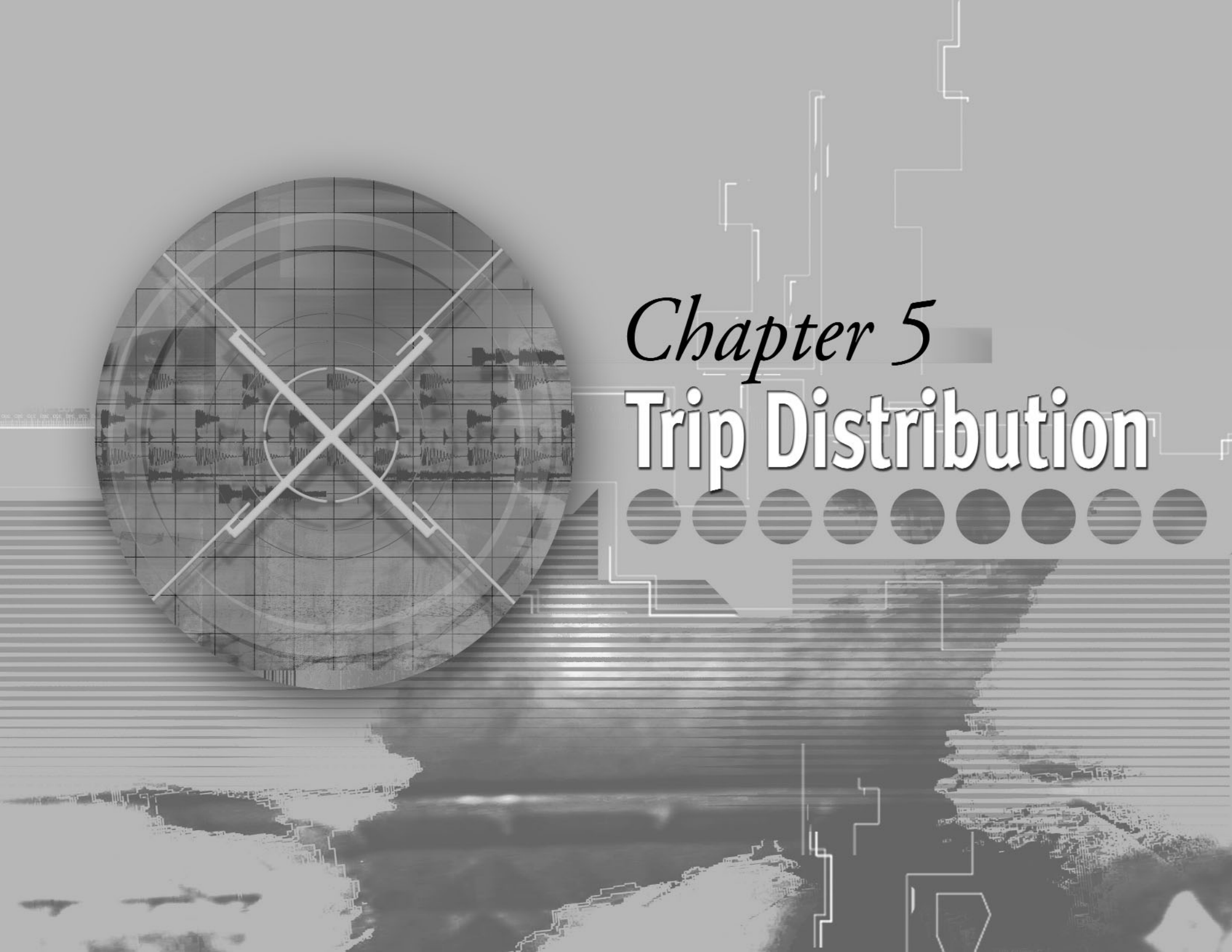
The heavy-duty truck network incorporates special network coding that allows heavy-duty trucks to be converted into Passenger Car Equivalents (PCEs). This enables the Model to account for the effects of trucks on facility capacity in the mixed flow vehicle traffic stream.

Table 4-7

TRANSIT NETWORK ROUTES, CENTERLINE AND REVENUE MILES

Transit Mode Number	Description	Routes		Vehicles	Roadway Centerline Miles		Daily Revenue Miles	
		Peak	Offpeak	Peak	Peak	Offpeak	Peak	Offpeak
10	Metrolink Rail	27	11	43	412	292	7,098	2,758
11	MTA Local Bus	350	337	1,803	1,795	1,792	136,303	101,085
12	MTA Express Bus	50	50	215	618	618	23,793	16,317
13	Urban Rail (MTA Metrorail)	5	4	46	57	57	7,461	5,661
14	LA County Express Bus	85	28	427	1,054	421	53,398	13,672
15	LA County Local Bus (Group 1)	56	50	166	477	438	14,944	14,244
16	LA County Local Bus (Group 2)	140	119	390	525	505	26,008	26,959
17	LA County Local Bus (Group 3)	114	114	239	574	580	14,162	18,209
18	LA County Local Bus (Group 4)	2	2	8	6	6	350	373
19	All Non-LA County Local Bus	274	256	659	2,184	2,185	51,924	59,337
20	All Non-LA County Express Bus	21	10	42	448	250	4,790	2,896
22	MTA Rapidbus	2	2	31	40	40	3,844	4,010
All		1,126	983	4,069	8,189	7,184	344,075	265,521

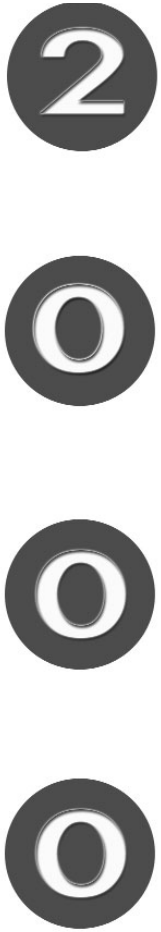
Notes:
Peak Period: 6-9 AM
Offpeak Period: 9AM-3PM



Chapter 5
Trip Distribution

Trip Distribution

Chapter 5



Introduction

Trip distribution is the process of taking all person productions and linking them with specific attractions. When this is done for all zones, a "trip table" of trip interchanges between TAZs results. Trip distribution is preformed separately for each of the 13 trip types using a tool known as a "gravity model". A gravity model estimates the number of trips between two TAZs in direct proportion to the relative attraction of the zones and inversely proportional to the spatial separation between the zones.

This Chapter summarizes the process for creating the trip tables by trip type for the Year 2000 Model Validation. A feedback procedure called convergence is used to "feedback" congested conditions on the transportation network, into the gravity model's allocation of trips between zones. The procedure is described below. The methodology for "recombining" trip tables by trip type for input into the mode choice model is also identified. This Chapter then presents statistics summarizing trip making within and between the five counties in the modeling area, showing total person trip productions and attractions by county. Finally, the mean (or average) travel time by trip types are presented, as well as the overall average trip length for all trip types. These statistics are also compared to similar statistical data from the 1997 Model Validation.

Description of the Trip Distribution Model

SCAG's distribution model is applied to the productions and attractions from trip generation for each of the 13 trip purposes. The productions and attractions are split into the two time periods (peak and off-peak) using the trips-in-motion factors presented in Table 8-1. The distribution model is run twice for each trip type to account for peak and off-peak travel conditions. The distribution process creates a total of twenty-six, zone-to-zone person trip matrices, one for each trip type in the "peak" and "off peak" time periods.

- The **"Peak"** period of the day consists of the A.M. and P.M. peak periods (see Table 8-1, Trips in Motion Factors).
- The **"Off-Peak"** period of the day consists of the Midday and Night periods (see Table 8-1, Trips in Motion Factors).

The Regional Model uses a gravity model approach to distribute trips. Trips between a pair of analysis zones or TAZs are directly proportional to the trip ends in both the zone of production and in the zone of attraction. In addition, trips are inversely proportional to a function of the time or cost to travel between the two zones. The term "travel impedance" is used to represent the time, or cost (or both), to travel between a specific pair of zones. In the Year 2000 Regional Model, the "travel impedance" used in trip distribution is as follows:

- For home-based work trips, the "travel impedance" applied in the model is the "logsum", a composite impedance taken from the denominator of the logit mode choice model for home-based work trips (reference Chapter 6).
- For all other trip types, the travel impedance is the travel time between the zones along the travel network.

A variable known as a "friction factor" is then applied. "Friction factors", or travel impedance factors, express the effect that spatial separation exerts on the probability of making a trip to a given zone. "Friction factors" (or curves of such data) were developed from the 1991 Origin-Destination Survey data. These friction factor curves were applied in the process of calibrating the gravity model. The gravity model uses twenty-six friction factor curves, one for each combination of trip type and time period.

The 26 trip tables outputted from the trip distribution process are combined to produce seven 3191-by-3191 zonal person trip tables for input to the mode choice model. The set of 14 trip type tables (7 trip types-Peak/Off-Peak) include:

- Home-based work trips, "low income" category
- Home-based work trips, "medium income" category, also includes college trips
- Home-based work trips, "high income" category
- Home-based school trips
- Home-based other trips, representing all other home-based trip types not represented in the four previous "home-based" categories
- Work-other trips
- Other-other trips

Convergence Process

In the Year 2000 Model Validation run, several "feedback loops" were made through the trip generation, trip distribution, mode choice, and trip assignment processes to better estimate travel impedance (time and cost) along the travel network. This was necessary to more realistically model trip distribution and mode choice. The process is
detailed below:

- The trip distribution model was run a first time, with "observed speeds" coded in the input highway network used to calculate the initial zone-to-zone travel times.
- Trip tables for the highway modes were then run through highway assignment. This process produced "first pass" highway assignments and yielded model-estimated congested speeds along the highway network.
- The congested speeds were then used to rebuild transit network fed back into the trip generation model.
- Trip distribution, mode choice, and highway assignment, were then run again, producing a more refined set of congested speeds along the network. An averaging process is utilized to smooth the variation between the first pass (or first loop) trip assignment and the second pass

(or second loop) trip assignment.

- The refined speeds were then fed back a second time into the trip distribution model.
- Trip distribution, mode choice, highway assignment, and the averaging process were run for the third time.

For the Year 2000 and future year model runs, a standardized five-loop process is applied to ensure a less than one percent margin in VMT estimates between successive loops.

Trip Distribution Results And Findings

Tables 5-1 and 5-2 present summary statistics resulting from the trip distribution process for the Year 2000 Model Validation run. Both Tables are summaries of trip tables in Production-Attraction (P & A) format. P & A format differs from origin-destination format in that the return trips, such as those from work-to-home, are actually credited as home-to-work trips. On a daily basis, half of the trips in those tables move from the zone of production to the zone of attraction and the other half of the trips move from the zone of attraction to the zone of production. Table 5-1 presents distribution results for home-based work trips, and Table 5-2 presents a summary of all trips.

The Year 2000 person-trip distribution model estimated inter-county travel patterns consistent with validations of previous Regional Transportation Models. The Year 2000 Model estimated that approximately 92.5 percent of the home-work trips generated in Los Angeles County had destinations within the Los Angeles County. Orange County retained 79.7 percent of its Year 2000 estimated home-work trips and Ventura County's estimated intra-county home-work trip percentage was 76.6 percent. San Bernardino County's estimated intra-county work trip percentage was 64.9 percent, while Riverside County's intra-county home-work trip percentage was estimated at 68.3 percent.

Table 5-3 presents average travel time statistics for the distribution of trips in the Year 2000 Model. The average A.M. travel time for a home-based work trip was 24.1 minutes. The average mid-day travel time for a home-based work trip was 17.6 minutes.

Figure 5-1 shows the distribution patterns of Year 2000 home-work trips to Los Angeles, Ontario, and Irvine Central Business Districts.

Figure 5-2 displays the average travel time to downtown Los Angeles from 6:00 A.M. to 9:00 A.M.

Figure 5-3 displays the average travel time to Warner Center from 6:00 A.M. to 9:00 A.M.

Note - Distribution trips are reduced to account for the elimination of Transportation Demand Management(TDM) and external trips.

Table 5-1

HOME-BASED WORK PERSON TRIP DISTRIBUTION

From / To	LOS ANGELES	ORANGE	RIVERSIDE	SAN BERNARDINO	VENTURA	TOTAL PRODUCTIONS
LOS ANGELES	4,739,287 ***92.45%***	277,713 *5.42%*	6,927 *0.14%*	52,132 *1.02%*	50,088 *0.98%*	5,126,147 *100.00%*
ORANGE	329,603 *18.87%*	1,392,608 ***79.74%***	12,516 *0.72%*	11,768 *0.67%*	- *0.00%*	1,746,495 *100.00%*
RIVERSIDE	45,577 *6.10%*	87,362 *11.69%*	510,513 ***68.33%***	103,684 *13.88%*	13 *0.00%*	747,149 *100.00%*
SAN BERNARDINO	152,835 *17.83%*	53,698 *6.26%*	94,432 *11.01%*	556,271 ***64.88%***	151 *0.02%*	857,387 *100.00%*
VENTURA	106,442 *23.33%*	254 *0.06%*	4 *0.00%*	98 *0.02%*	349,459 ***76.59%***	456,257 *100.00%*
TOTAL ATTRACTIONS	5,373,744 *60.15%*	1,811,635 *20.28%*	624,392 *6.99%*	723,953 *8.10%*	399,711 *4.47%*	8,933,435 *100.00%*

Table 5-2

TOTAL PERSON TRIP DISTRIBUTION

From / To	LOS ANGELES	ORANGE	RIVERSIDE	SAN BERNARDINO	VENTURA	TOTAL PRODUCTIONS
LOS ANGELES	30,091,455 ***95.26%***	987,816 *3.13%*	41,262 *0.13%*	284,718 *0.90%*	183,364 *0.58%*	31,588,615 *100.00%*
ORANGE	1,093,323 *10.41%*	9,295,302 ***88.53%***	60,650 *0.58%*	50,096 *0.48%*	230 *0.00%*	10,499,601 *100.00%*
RIVERSIDE	124,288 *2.54%*	190,617 *3.89%*	4,173,741 ***85.25%***	407,425 *8.32%*	50 *0.00%*	4,896,121 *100.00%*
SAN BERNARDINO	500,916 *9.15%*	126,359 *2.31%*	417,445 *7.62%*	4,430,677 ***80.91%***	344 *0.01%*	5,475,741 *100.00%*
VENTURA	371,221 *13.64%*	1,193 *0.04%*	44 *0.00%*	472 *0.02%*	2,348,487 ***86.30%***	2,721,417 *100.00%*
TOTAL ATTRACTIONS	32,181,203 *58.32%*	10,601,287 *19.21%*	4,693,142 *8.50%*	5,173,388 *9.38%*	2,532,475 *4.59%*	55,181,495 *100.00%*

Note - Distribution trips are reduced to account for the elimination of T.D.M. and external trips.

Table 5-3

YEAR 2000 AVERAGE AUTO PERSON TRIP LENGTHS BY COUNTY

AM-Peak Period:

County	Trip Purpose	HBW	HBO	HBSch	OBO	WBO
LA	Time (minutes)	21.44	13.02	11.00	13.41	15.57
	Distance (miles)	11.28	6.81	5.40	7.15	8.89
ORA	Time (minutes)	20.51	12.51	10.14	12.79	14.28
	Distance (miles)	11.60	6.92	5.16	7.20	8.37
RIV	Time (minutes)	29.51	14.89	9.86	12.39	15.78
	Distance (miles)	18.33	9.19	5.53	7.55	10.09
SBD	Time (minutes)	26.49	16.25	9.23	12.63	16.23
	Distance (miles)	16.42	10.03	5.30	7.74	10.41
VEN	Time (minutes)	21.75	13.03	8.82	10.69	13.13
	Distance (miles)	13.30	7.77	4.90	6.43	8.19
ALL	Time (minutes)	22.49	13.41	10.46	12.98	15.26
	Distance (miles)	12.58	7.42	5.34	7.22	8.97

Midday Period:

County	Trip Purpose	HBW	HBO	HBSch	OBO	WBO
LA	Time (minutes)	18.63	11.53	9.84	12.00	13.82
	Distance (miles)	11.85	7.06	5.44	7.21	8.86
ORA	Time (minutes)	18.58	11.30	9.38	11.76	13.13
	Distance (miles)	12.23	7.00	5.18	7.27	8.55
RIV	Time (minutes)	22.59	13.03	9.31	11.41	14.39
	Distance (miles)	16.68	8.98	5.53	7.57	10.37
SBD	Time (minutes)	20.96	13.70	8.85	11.67	14.72
	Distance (miles)	15.21	9.53	5.31	7.79	10.62
VEN	Time (minutes)	17.54	10.66	8.39	9.92	11.95
	Distance (miles)	12.19	7.05	4.85	6.40	6.19
ALL	Time (minutes)	19.11	11.79	9.54	11.77	13.71
	Distance (miles)	12.66	7.46	5.37	7.28	9.04

Figure 5-1

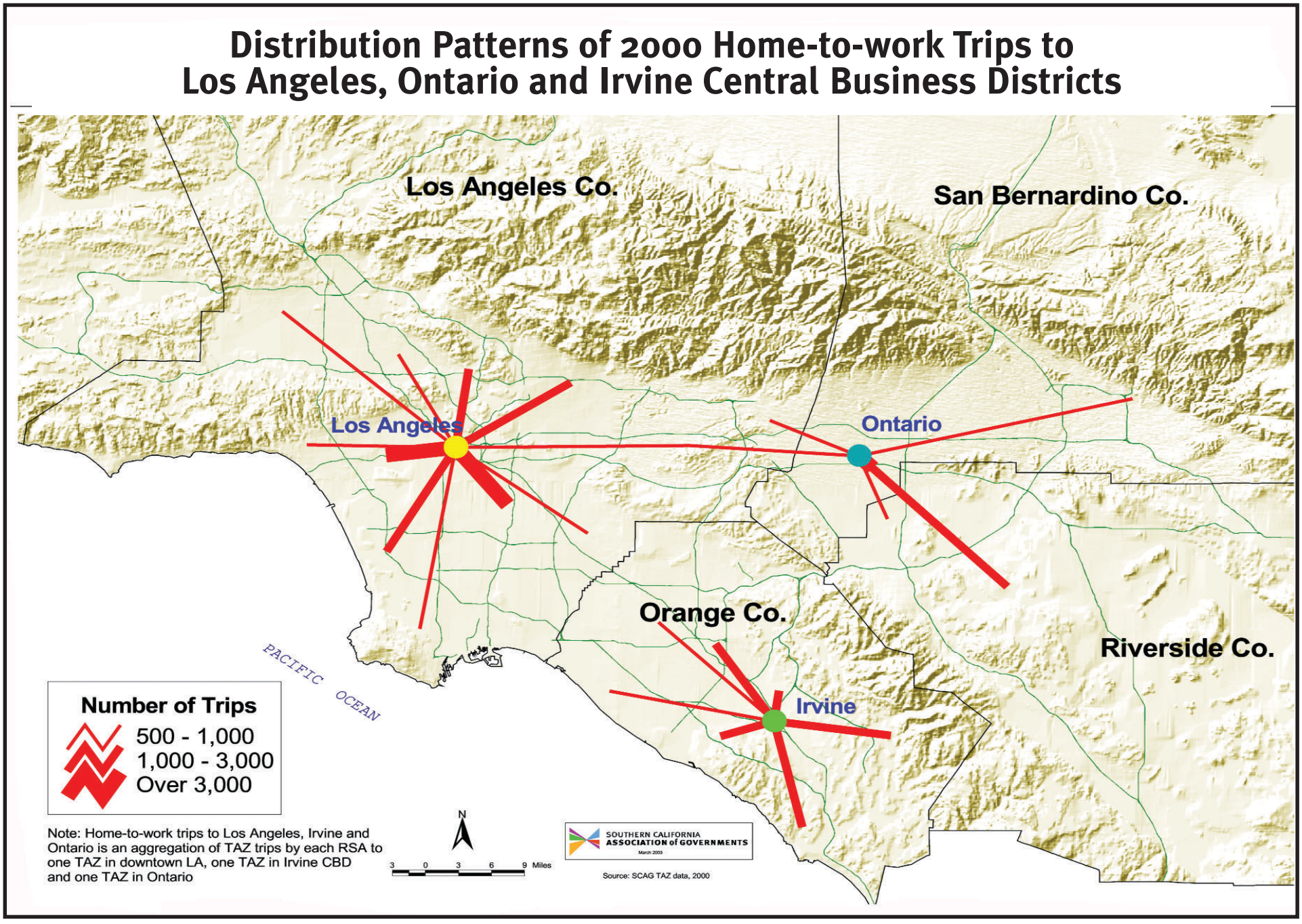

Distribution Patterns of 2000 Home-to-work Trips to
Los Angeles, Ontario and Irvine Central Business Districts
Los Angeles Co.
San Bernardino Co.
Los Angeles
Ontario
Orange Co.
Riverside Co.
Irvine
PACIFIC OCEAN
Number of Trips
500 - 1,000
1,000 - 3,000
Over 3,000
Note: Home-to-work trips to Los Angeles, Irvine and Ontario is an aggregation of TAZ trips by each RSA to one TAZ in downtown LA, one TAZ in Irvine CBD and one TAZ in Ontario
N
3 0 3 6 9 Miles
SOUTHERN CALIFORNIA ASSOCIATION of GOVERNMENTS
Source: SCAG TAZ data, 2000

Figure 5-2

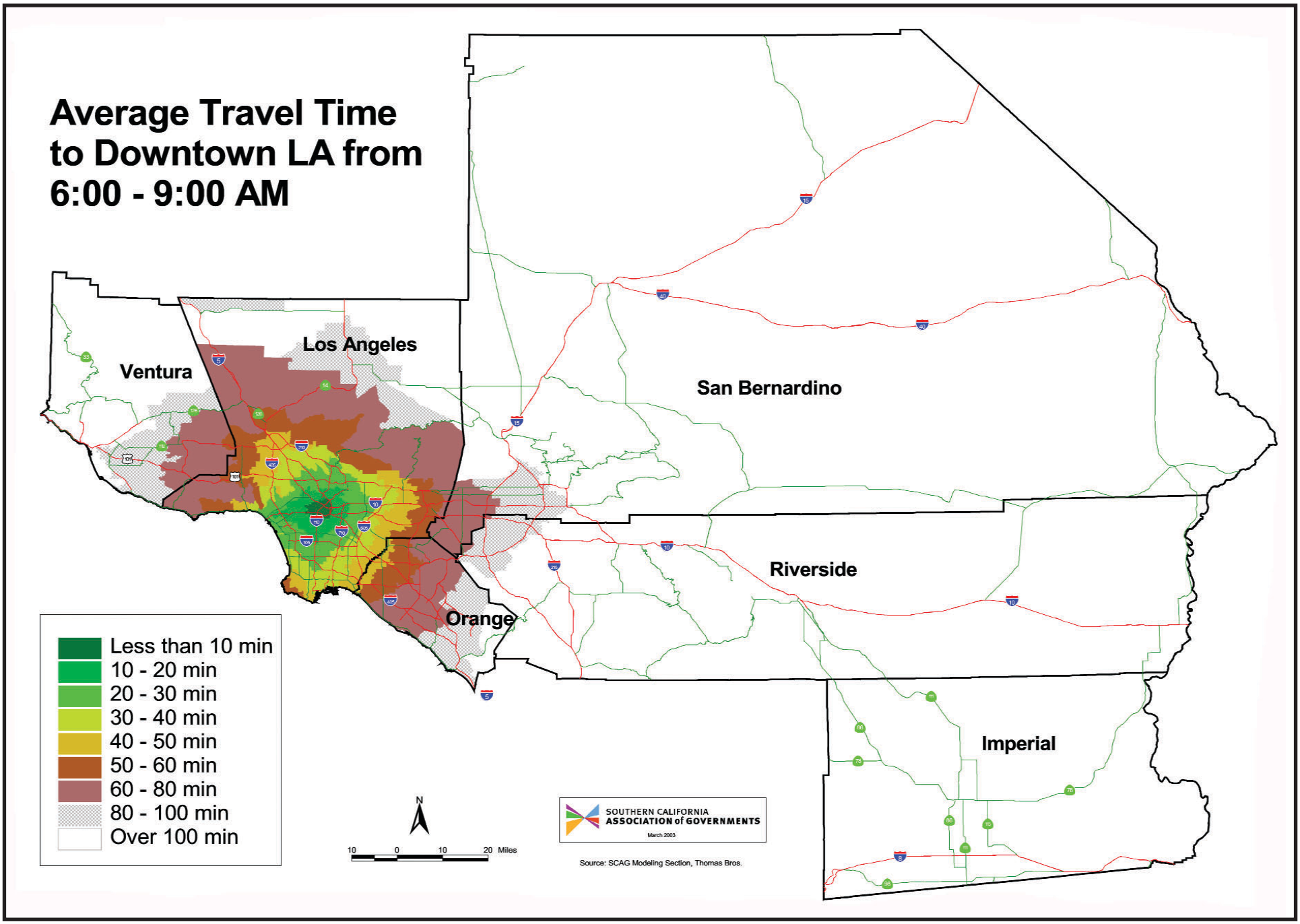
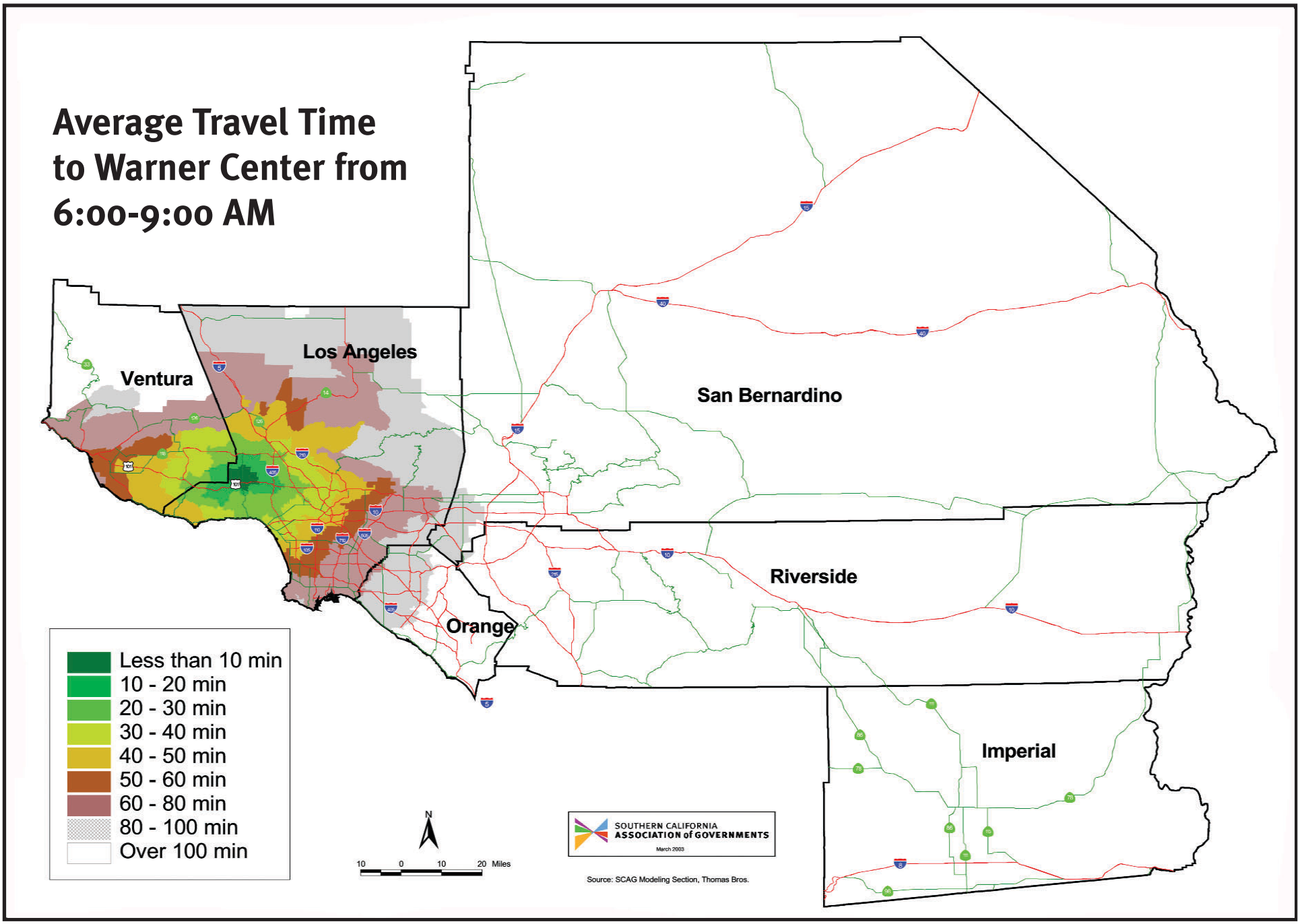

Average Travel Time
to Downtown LA from
6:00 - 9:00 AM
Ventura
Los Angeles
San Bernardino
Riverside
Orange
Imperial
Less than 10 min
10 - 20 min
20 - 30 min
30 - 40 min
40 - 50 min
50 - 60 min
60 - 80 min
80 - 100 min
Over 100 min
N
10 0 10 20 Miles
SOUTHERN CALIFORNIA
ASSOCIATION of GOVERNMENTS
March 2003
Source: SCAG Modeling Section, Thomas Bros.

Figure 5-3


Average Travel Time
to Warner Center from
6:00-9:00 AM
Ventura
Los Angeles
San Bernardino
Riverside
Orange
Imperial
Less than 10 min
10 - 20 min
20 - 30 min
30 - 40 min
40 - 50 min
50 - 60 min
60 - 80 min
80 - 100 min
Over 100 min
N
10 0 10 20 Miles
SOUTHERN CALIFORNIA
ASSOCIATION of GOVERNMENTS
March 2003
Source: SCAG Modeling Section, Thomas Bros.

Chapter 6
Mode Choice

Mode Choice

Chapter 6

Introduction

Mode choice is the process of taking the zone-to-zone person trips by trip purpose from the trip distribution model, and determining how many of those person-trips are made by the various travel modes: non-motorized modes (bicycle or walking), by automobile (as a driver, or as a passenger), or by transit.

The Year 2000 Regional Transportation Model incorporates a new set of calibrated and validated mode choice models for the Region. The model set was developed, and calibrated based on the Year 1991 Southern California Origin-Destination Travel Survey, which was supplemented by transit on-board survey data.

This Chapter presents a description of the mode choice model, and presents summary statistics from its application in the Year 2000 Model Validation run. The various travel modes estimated by the model are also summarized and explained.

Description of the Mode Choice Model

There were a total of five separate mode choice models applied during development of the Year 2000 Model. Each of the models is applied for both the peak and off-peak periods. A description of how the five mode choice models are applied to the 7 trip purpose tables from trip distribution is described below:

Mode Choice Models

- **Home-based work mode choice**

  Home-based work trips are trips that have an at-home activity at one end of a trip and a work, work-related, or school activity (for travelers aged 18 or over) at the other end of the trip. For purposes of mode choice modeling, college/university trips were found to be behaviorally similar to home-based work trips and were added to the home-based work, medium income trip table. The home-base work mode choice model is run for each income category (high, medium, and low). The Level of Service (LOS) variable (value of time) is varied between the three runs to better reflect the travel behavior of the three income groups. The home-based work mode choice model aggregates the results from the three mode choice runs and outputs 10 tables, one for each travel mode plus total trips.

- **Home-based school mode choice**

  Home-based school trips are equivalent to the home-based school trip category defined in the trip generation classification as K-12 (kindergarten through 12th grade) school trips. The home-based school mode choice model outputs 6 trip tables, one for each travel mode plus total trips.

- **Home-based other mode choice**

  Home-based other trips include all home-based trips not included in the two categories described above. The home-based other mode choice model outputs 10 trip tables, one for each travel mode plus total trips.

- **Work-other mode choice**

  Work-other trips are trips that have a work or work-related activity at one end of a trip, and a non-home activity at the other end of a trip. The work-other mode choice model outputs 8 trip tables, one for each travel mode plus total trips.

- **Other-other mode choice**

  Other-other trips include all trips that have activities at both ends of a trip that are other than home, work, or school related. The other-other mode choice model outputs 6 trip tables, one for each travel mode plus total trips.

Travel Modes

The mode choice model outputs up to 10 modes depending on the trip purpose. Not all of the modes listed below are estimated by each of the five mode choice models. Table 6-1 indicates the modes included in each of the five mode choice models.

Non-motorized Modes

- **Non-motorized:**

Trips made by walking or by bicycle.

Auto Modes

- **Drive Alone:** the trip maker is an auto driver without passengers.
- **Auto Passenger:** the trip maker is a passenger in an auto driven by someone else.
- **Drive/2 occupants:** the trip maker is an auto driver with one passenger.
- **Drive/3+ occupants:** the trip maker is an auto driver with two or more passengers.

Transit Modes

- **Transit with Walk Access:** The trip maker walks to the transit stop or station, rather than driving or being dropped off. For certain trip purposes these transit trips are subdivided according to whether the transit service is "Local Transit" or "Express Transit".
- **Transit with Auto Access:** The trip maker is driven to or drives to the transit station or transit stop, such as to a park-and-ride lot (includes kiss-and-ride trips). For certain trip purposes these transit trips are also subdivided according to whether the transit service is "Local Transit" or "Express Transit".
- **School Bus Mode**
  Includes students transported by school bus.

Model Structure

The model structures that were derived for each of the five mode split choice models are as follows:

Home-Based Work	Nested Logit Model
Home-Based School	Nested Logit Model
Home-Based Other	Multinomial Logit Model
Work-Based Other	Multinomial Logit Model
Other-Based Other	Nested Logit Model

Table 6-1

TRAVEL MODES ESTIMATED BY EACH OF THE FIVE (TRIP PURPOSE) MODE CHOICE MODELS

Travel Mode Category	Mode	Home Based Work	Home Based School	Home Based Other	Work-Other	Other-Other
Nonmotorized Modes	(Walk trips, bike trips)	◆	◆	◆	◆	◆
Auto Modes:						
	"Drive Alone"	◆		◆	◆	◆
	"Auto Passenger"	◆	◆	◆	◆	◆
	"Drive/ 2 occupants"	◆		◆	◆	◆
	"Drive/ 3 occupants"	◆		◆	◆	◆
Transit Modes:						
	"Transit/ Walk Access":				◆	◆
	Local Transit	◆	◆	◆		
	Express Transit	◆		◆		
	"Transit/ Auto Access":				◆	◆
	Local Transit	◆	◆	◆		
	Express Transit	◆		◆		
School Bus			◆			

Details regarding the structure and key variable coefficients for each mode choice model are presented in Appendix F.

Mode Choice Results and Findings

Table 6-3 presents a comprehensive overview of mode choice modeling results for the Year 2000 Model Validation run, by county and for the modeling area as a whole. Table 6-2 shows results of the home-base work and university trips mode choice. Table 6-3 identifies the estimated number of vehicle trips, vehicle passengers, transit trips, non-motorized trips, and school bus trips made for all trip purposes. The results are tallied sepa-

Table 6-2

MODE CHOICE SUMMARY STATISTICS HOME-BASED WORK AND UNIVERSITY

	LOS ANGELES		ORANGE		RIVERSIDE		SAN BERNARDINO		VENTURA		TOTAL	
Vehicle Trips	4,955,161	80.58%	1,749,278	85.23%	771,279	85.11%	884,108	84.71%	463,597	86.19%	8,823,422	82.54%
Drive Alone	4,601,141	74.82%	1,632,261	79.53%	710,684	78.43%	816,867	78.26%	433,571	80.61%	8,194,524	76.66%
2 Person Carpool	256,192	4.17%	84,755	4.13%	43,066	4.75%	47,911	4.59%	21,970	4.08%	453,895	4.25%
3+ Person Carpool	97,828	1.59%	32,261	1.57%	17,529	1.93%	19,329	1.85%	8,055	1.50%	175,003	1.64%
Auto Passenger Trips	498,671	8.11%	163,058	7.94%	87,314	9.64%	96,705	9.27%	41,805	7.77%	887,553	8.30%
Vehicle Occupancy	1.10		1.09		1.11		1.11		1.09		1.10	
Transit Trips	400,237	6.51%	60,894	2.97%	17,227	1.90%	27,889	2.67%	5,947	1.11%	512,195	4.79%
Non-Motorized Person Trips	295,400	4.80%	79,233	3.86%	30,360	3.35%	35,021	3.36%	26,536	4.93%	466,550	4.36%
Total Person Trips	6,149,469	100.00%	2,052,463	100.00%	906,181	100.00%	1,043,722	100.00%	537,885	100.00%	10,689,720	100.00%

rately for peak period travel, off-peak period travel, and total daily travel. Estimated vehicle occupancy by county and by time period is also included in Table 6-3.

The mode choice model produced an estimated 512,195 daily home-work transit trips in the model area. The remaining (non-transit) home-work trips were estimated at 8,823,422 vehicle trips and subdivided by vehicle occupancy as follows:

- 8,194,524 “drive alone” vehicle trips
- 453,895 two-person vehicle trips
- 175,003 vehicle trips carrying three or more persons

Total weekday transit ridership was 1,185,606. Daily vehicle trips totaled 33,967,001, resulting in an average vehicle occupancy of 1.43 persons per vehicle.

Table 6-3

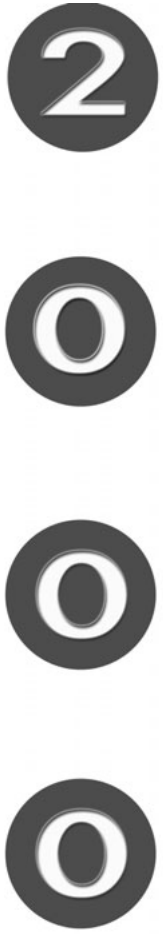
MODE CHOICE SUMMARY STATISTICS, ALL TRIP PURPOSES

PEAK PERIODS	LOS ANGELES		ORANGE		RIVERSIDE		SAN BERNARDINO		VENTURA		TOTAL	
Vehicle Trips	9,617,031	58.73%	3,449,084	63.70%	1,525,586	60.28%	1,701,891	59.67%	890,743	63.33%	17,184,335	60.13%
Auto Passenger Trips	4,335,600	26.48%	1,393,646	25.74%	698,467	27.60%	793,395	27.82%	354,441	25.20%	7,575,549	26.51%
Vehicle Occupancy	1.45		1.40		1.46		1.47		1.40		1.44	
Transit Trips	595,035	3.63%	80,251	1.48%	22,854	0.90%	36,824	1.29%	7,797	0.55%	742,760	2.60%
Non-Motorized Person Trips	1,567,774	9.57%	411,568	7.60%	191,314	7.56%	224,115	7.86%	126,551	9.00%	2,521,322	8.82%
School Trips by School Bus	260,552	1.59%	79,645	1.47%	92,741	3.66%	96,056	3.37%	26,933	1.91%	555,927	1.95%
Total Person Trips	16,375,992	100%	5,414,194	100%	2,530,962	100%	2,852,281	100%	1,406,465	100%	28,579,893	100%
OFF-PEAK PERIODS												
Vehicle Trips	9,367,057	61.57%	3,338,946	65.66%	1,528,512	64.63%	1,681,716	64.10%	866,436	65.89%	16,782,666	63.09%
Auto Passenger Trips	4,065,255	26.72%	1,336,105	26.27%	650,914	27.52%	730,505	27.85%	342,687	26.06%	7,125,465	26.79%
Vehicle Occupancy	1.43		1.40		1.43		1.43		1.40		1.42	
Transit Trips	370,982	2.44%	41,440	0.81%	9,235	0.39%	17,426	0.66%	3,764	0.29%	442,847	1.66%
Non-Motorized Person Trips	1,325,145	8.71%	343,508	6.75%	145,786	6.16%	162,637	6.20%	93,010	7.07%	2,070,086	7.78%
School Trips by School Bus	84,087	0.55%	25,409	0.50%	30,713	1.30%	31,176	1.19%	9,055	0.69%	180,440	0.68%
Total Person Trips	15,212,525	100%	5,085,407	100%	2,365,159	100%	2,623,460	100%	1,314,952	100%	26,601,503	100%
ALL TIME PERIOD COMBINED												
Vehicle Trips	18,984,087	60.10%	6,788,030	64.65%	3,054,098	62.38%	3,383,607	61.79%	1,757,179	64.57%	33,967,001	61.56%
Auto Passenger Trips	8,400,855	26.59%	2,729,751	26.00%	1,349,381	27.56%	1,523,901	27.83%	697,128	25.62%	14,701,014	26.64%
Vehicle Occupancy	1.44		1.40		1.44		1.45		1.40		1.43	
Transit Trips	966,017	3.06%	121,691	1.16%	32,088	0.66%	54,249	0.99%	11,561	0.42%	1,185,606	2.15%
Non-Motorized Person Trips	2,892,919	9.16%	755,076	7.19%	337,100	6.89%	386,753	7.06%	219,561	8.07%	4,591,408	8.32%
School Trips by School Bus	344,639	1.09%	105,053	1.00%	123,454	2.52%	127,232	2.32%	35,989	1.32%	736,367	1.33%
Total Person Trips	31,588,517	100%	10,499,601	100%	4,896,121	100%	5,475,741	100%	2,721,417	100%	55,181,397	100%

Chapter 7
Heavy-Duty Truck Model

Heavy-Duty Truck Model

Chapter 7



Introduction

The SCAG Year 2000 Regional Model incorporates a computerized heavy duty truck model, which estimates trip generation, distribution, and traffic assignment for Heavy-Duty Trucks (HDT). According to the California Air Resources Board (CARB), a heavy-duty truck is defined as a truck with a gross vehicle weight of 8,500 pounds or more. The HDT Model is fully integrated with the SCAG Regional Transportation Model. It employs truck trip generation rates, and uses a network of regional highway facilities for truck traffic assignment. The truck traffic assignment process is integrated with the assignment process for light-and-medium duty vehicles in the Regional Model, so that the effects of congestion on truck route choice are represented. The integration of the trip assignment process for both models is necessary so that the effects of truck activity on light-and-medium duty vehicles in the traffic stream are also represented.

The HDT Model is extensively documented in a separate report prepared for SCAG. Heavy Duty Truck Model and VMT Estimation, Meyers, Mohaddes Associates, Inc. The content of this Chapter is limited to a brief overview of the Model and a discussion of how the HDT Model was used to generate and distribute heavy-duty truck trips for the Year 2000 Model Validation Run. The assignment and Vehicle Miles Traveled (VMT) results for the HDT traffic component of the Model are presented in Chapter 8.

Description of the HDT Model

The HDT Model is designed to develop forecasts of heavy-duty trucks in the following three Gross Vehicle Weight (GVW) categories:

- **Light-Heavy:** 8,500 to 14,000 pounds GVW
- **Medium-Heavy:** 14,000 to 33,000 pounds GVW
- **Heavy-Heavy:** over 33,000 pounds GVW

The Model is specifically designed to forecast truck movements in the Region for air quality conformity determinations. As such, it produces VMT estimates for the three truck weight classifications identified above. The HDT Model employs socioeconomic data by Traffic Analysis Zone (TAZ), with employment data broken down into further detail by Standard Industrial Classification (SIC) code to better estimate commodity flow demand that correspond to truck travel demand.

Table 7-1

DAILY TRIP RATES FOR INTERNAL TRUCK TRIP GENERATION

Employment Category	LIGHT HDV	MEDIUM HDV	HEAVY HDV
Households	0.0390	0.0087	0.0023
Agriculture/Mining/Construction	0.0513	0.0836	0.0569
Retail	0.0605	0.0962	0.0359
Government	0.0080	0.0022	0.0430
Manufacturing	0.0353	0.0575	0.0391
Transportation/Utility	0.2043	0.0457	0.1578
Wholesale	0.0393	0.0650	0.0633
Other	0.0091	0.0141	0.0030

Notes: Rates are per household or per employee in each category.

External truck trips, trips with a trip end outside of the SCAG Region were developed from estimated incoming and outgoing commodity flows. The internal ending points of those trips are allocated to TAZs within the SCAG Region. Truck trips "internal" to the Region are estimated from shipping and receiving daily truck trip generation rates corresponding to the number of employees in various employment sectors in each zone, and in certain cases, with the number of households in each zone. Special truck activity trip tables were developed for special truck trip generators, such as ports and airports.

Truck Trip Generation and Distribution

The internal truck trip generation model uses a cross-classification methodology using 1-digit employment categories by mode of trucks. Table 7-1 shows the various employment categories and the trip rates used for each category by truck type.

The results from the internal truck generation model are shown in Table 7-2 that breaks down the trucks generated for each truck type by the employment category and summarized by counties.

The external truck trips are generated and distributed using a combination of commodity flow data at the county level and 2-digit employment data for allocating county data to TAZs. External to external truck trips were developed by adjusting the 2001 RTP 2000 truck tables.

Table 7-2

HEAVY-DUTY VEHICLE INTERNAL TRIP GENERATION BY COUNTY AND BY SECTOR

COUNTY	LIGHT HDV	MEDIUM HDV	HEAVY HDV	TOTAL
Los Angeles	273,320	207,464	141,862	622,646
Orange	85,688	74,338	45,776	205,802
Riverside	37,475	28,570	17,528	83,573
San Bernardino	44,580	31,530	22,916	99,026
Ventura	21,268	17,696	11,371	50,335
ALL COUNTIES	**462,331**	**359,598**	**239,453**	**1,061,382**

SECTOR	LIGHT HDV	MEDIUM HDV	HEAVY HDV	TOTAL
Households	208,423	46,494	12,292	267,209
Ag/Mining/Const	23,524	38,336	26,092	87,952
Retail	75,651	120,292	44,891	240,834
Governments	4,661	1,282	25,053	30,996
Manufacturing	37,602	61,250	41,650	140,502
Transportation/Utility	63,917	14,298	49,369	127,584
Wholesale	18,808	31,585	30,293	80,686
Other	29,743	46,086	9,806	85,635
ALL SECTORS	**462,329**	**359,623**	**239,446**	**1,061,398**

Note: County totals are based on integer P-A file. Sector totals are based floating point summations

Port related truck trips were developed by updating the 2001 RTP 2000 port trip tables to the most recent port related truck estimates. Air cargo trip tables for Year 2000 were developed by consultant with the proprietary RADAM model.

Average internal truck trip length in miles is 5.592 for Light, 12.827 for Medium, and 23.914 for Heavy. Truck specific time period factors, derived from California Weigh In Motion (WIM) truck data, were applied to allocate daily truck activity into the four model time periods (A.M. peak, Midday, P.M. peak, and Night). Trucks are converted into passenger car equivalents during the assignment phase. The trip assignment process simultaneously loads both heavy-duty trucks and light-and-medium duty autos/trucks so that all vehicle types are accounted for in the traffic stream.

Truck PCE is estimated for each link by the product of a grade factor and a congestion factor. The grade factors range from 1.2 to 3.6 for Light, 1.5 to 4.5 for Medium, and 2.0 to 6.0 for Heavy HDV. The congestion factors range between 1.0 and 1.3.

The HDT Model was validated against a number of specific parameters including:

- The Model estimated Year 2000 truck movements across 16 regional screenlines to within twelve percent of the corresponding truck traffic counts (all screenlines combined).
- All differences on individual screenlines were well within allowable tolerances established for regional modeling processes.
- The Model estimated 22.4 million VMT by all trucks within the SCAG modeling region. This was compared to be within 2 percent of the VMT estimates from the Highway Performance and Monitoring System (HPMS). Results are shown in Chapter 8.

HDT Model Results and Findings

The truck traffic assignment results are documented in the SCAG regional screenline summaries and in the assignment VMT summaries tabulated and presented in Chapter 8. The HDT Model produces reasonable results based on the screenline summaries and VMT comparisons.

The Regional Travel Demand Model assumes the same speed for all vehicles traveling on the same roadway segment. For instance, both HDTs and passenger cars are loaded on the same segment of the roadway and the current model cannot distinguish which lanes the heavy-duty trucks (HDTs) can travel. In order to reasonably represent the slower speeds that most trucks are traveling, a post model adjustment of the speed for the trucks were made using the available Freeway Performance Measurement Project (PeMs) data.

Post Model Adjustment of the Speed for the Heavy-Duty Trucks

Heavy-Duty Trucks (HDTs) travel on the same roadway segments as the general passenger cars, except for a small number of the truck only lanes. The Regional Travel Demand Model does not have a separate network for the heavy-duty trucks except truck only lanes. Both HDTs and

passenger cars are loaded on the same segment of the roadway disregarding the restriction on which lanes the HDTs can travel. Therefore, both HDTs and passenger cars have the same speed on the same output roadway segment.

The hypothesis is the heavy-duty trucks travel slower than the passenger cars as following:

1. Heavy-duty trucks can only travel on the outside lanes. HDT's choice of travel is relatively limited.
2. The speeds on outside lanes are interfered and thus slowed by incoming and outgoing vehicles.
3. The acceleration and deceleration of the HDT are much slower than the passenger vehicle.

The following section intends to find a relationship between HDT speed and the average roadway speed in order to conduct post model speed adjustment for the HDTs.

Speed of the Heavy-Duty Trucks on Freeways

As indicated in the previous section, 9361 records were selected through the PeMs database. A detailed review of the PeMs database revealed some problems associated with the PeMs database such as some detectors did not have data or speeds were out of the range. SAS programs were used to screen and analyze the database.

Only 3465 out of 9361 records were suitable to be used for the analysis. The dependent variable is the average speed of the outside two lanes. The independent variable is the average speed of the entire lanes at each detectors' location. A simple linear model was used to build the relationship between dependent variable and the independent variables.

The R-Square value is 0.98. The t statistics for the independent variable is 417.95. The equation of the result is: HDT speed = 0.31 + 0.9657* average freeway speed.

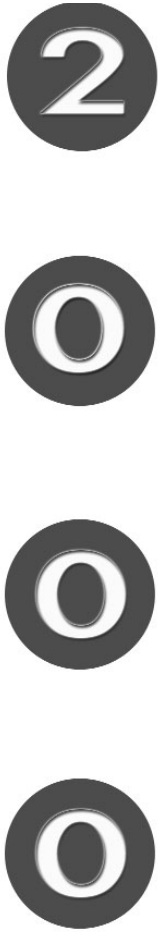
Speed of the Heavy-Duty Trucks on Arterials

There is no reliable data to derive the speed of the HDT on arterials. Nevertheless, the speed of the HDT is slower than the passenger cars as mention in the earlier section. SCAG plans to conduct arterial average speed study in FY03-04. For the current model validation, the speed of the HDT vs. passenger cars on arterials is assumed to be similar to the average speed of the heavy-duty trucks on freeways.

Chapter 8
Trip Assignment

Trip Assignment

Chapter 8



Introduction

This Chapter describes the various trip assignment methodologies and findings. Assignments used in the Year 2000 Model Validation include: a highway assignment to the street and highway network, a transit assignment to the transit network, a heavy-duty truck assignment integrated with the highway assignment for light-and-medium duty vehicles, and a toll assignment procedure to assign toll trips.

Highway assignment is the process of loading vehicle trips onto the appropriate highway network to produce traffic volumes, congested speeds, Vehicle Miles Traveled (VMT), and Vehicle Hours Traveled (VHT) estimates, for each of the four travel periods. Link or segment assignments by time period are added to produce average daily traffic volumes for the model network.

Highway assignment validation is critical in the modeling process. The ability of the model to produce current volume estimates within acceptable ranges of tolerance compared to actual ground counts is essential. The screenline analysis for the Year 2000 Model Validation run is presented in this Chapter. Also, key to assignment validation is the comparison of VMT estimated by the model, to estimates from the Highway Performance Monitoring System (HPMS). An acceptable tolerance level is mandatory for regional air quality planning and conformity purposes. Specifics regarding the comparative analysis are summarized in this Chapter and assignment statistics for the Region are also presented.

The SCAG Year 2000 Regional Transportation Model includes a complete Heavy-Duty Truck Model component, providing assignment results for heavy-duty trucks, as well as for light-and-medium duty vehicles. This Chapter presents the results of the truck traffic assignment combined with the results from the light-and-medium duty vehicle assignment. A description of the Heavy-Duty Truck Model is presented in Chapter 7.

This Chapter also briefly summarizes the results of the transit trip assignment. Transit trips are estimated by the mode choice model, and are assigned to transit routes to produce transit network loadings.

Time of Day Factoring

In the highway assignment, vehicle trips for all trip purposes are assigned, or loaded, onto the peak and off-peak period highway networks. Before this can be done, the trips in each of the vehicle trip tables in production-attraction format (except for other-other trips), from the mode choice model, must be converted to Origin-Destination (O-D) format by time of day. This conversion is accomplished using a set of peak and off-peak period factors derived from SCAG's 2000 Origin-Destination Survey. The time-of-day factors allocate the P & A formatted trips by trip purpose to each of the four time periods. Table 8-1 identifies the factors that were used in this process.

There are two sets of factors. The first is applied at the end of trip generation to subdivide trips by purpose into "peak" and "off-peak" subcategories for input into the trip distribution process. The second is applied prior to trip assignment to allocate peak trips into the A.M. and P.M. peak periods by direction of travel. It also allocates off-peak trips into midday and night-time periods by direction of travel. Both of these sets of factors are displayed

in Table 8-1. Table 8-1 also includes similar factors used to subdivide and stratify internal-external and external-internal trips (trips from within the Region with destinations outside of the Region and vice-versa). The Truck Model has unique factors to manipulate truck trips into directional O-D trip tables for each of the four time periods. Once all of the factors are applied, O-D trip tables are summed for all trip purposes and then assigned by time period.

External Trips

External trips (cordon trips) are trips with one or both ends outside the modeling area. External trips for the light-and-medium duty vehicles are estimated independently from heavy-duty vehicles (trucks). The following provides a brief description of the methodology used to estimate light-and-medium duty vehicle external trips. The external trip methodology used to develop truck cordon trips is described in the Heavy-Duty Truck Model Report.

Traffic counts were obtained for each cordon location to estimate Year 2000 cordon volumes. Previous cordon survey results were then used to split total external trips into two components: 1) through trips – External-to-External (E-E), and 2) External-to-Internal (E-I), and Internal-to-External (I-E). The through trip table (E-E) was developed by means of a Fratar process using the total through trips and the distribution from the previous Cordon Survey. The I-E and E-I trips were developed by distributing the total I-E/E-I trips to the appropriate internal zone using a gravity model approach. The resulting through trip table (E-E) and the I-E/E-I trip table were combined to create the total external trip table. Time-of-day factors were then applied to create the 4 trip tables by time period used in the assignment process.

Table 8-1

VEHICLE TRIPS-IN-MOTION FACTORS WITH PRELIMINARY DATA FROM THE YEAR 2000 SURVEY
(Shares of Daily Travel In Each of Four Time Periods)
(Peak and Off-Peak)

	P ⇢A	A ⇢P	Total
HOME-BASED WORK TRIPS			
AM 6-9	0.3234	0.0091	0.3325
PM 15-19	0.0237	0.3248	0.3486
"Peak"	0.3472	0.3339	0.6811
MD 9-15	0.0828	0.0615	0.1443
NT 19-6	0.0806	0.0941	0.1746
"Offpeak"	0.1633	0.1556	0.3189
HOME-BASED OTHER TRIPS			
AM 6-9	0.1307	0.0242	0.1550
PM 15-19	0.1026	0.2017	0.3042
"Peak"	0.2333	0.2259	0.4592
MD 9-15	0.2052	0.1463	0.3515
NT 19-6	0.0526	0.1367	0.1893
"Offpeak"	0.2578	0.2830	0.5408
HOME-BASED SCHOOL TRIPS			
AM 6-9	0.4112	0.0059	0.4171
PM 15-19	0.0562	0.2226	0.2788
"Peak"	0.4674	0.2285	0.6959
MD 9-15	0.0502	0.1981	0.2483
NT 19-6	0.0031	0.0527	0.0558
"Offpeak"	0.0533	0.2508	0.3041
WORK-BASED OTHER TRIPS			
AM 6-9	0.0349	0.0739	0.1089
PM 15-19	0.3243	0.0840	0.4082
"Peak"	0.3592	0.1579	0.5171
MD 9-15	0.2373	0.1913	0.4286
NT 19-6	0.0307	0.0236	0.0543
"Offpeak"	0.2680	0.2149	0.4829
OTHER-BASED OTHER TRIPS			
AM 6-9	0.0469	0.0469	0.0937
PM 15-19	0.1521	0.1521	0.3041
"Peak"	0.1989	0.1989	0.3979
MD 9-15	0.2518	0.2518	0.5035
NT 19-6	0.0493	0.0493	0.0986
"Offpeak"	0.3011	0.3011	0.6021

Note - P-->A
Indicates travel originated from production zone and ended at attraction zone

A-->P
Indicates travel originated from attraction zone and ended at production zone

Description of The Highway Assignment Procedures

Vehicle trip assignment is the process of loading vehicle trips onto the appropriate highway network. This process produces traffic volumes and resulting congested speeds on each road segment represented in the network for the four time period. Highway vehicle trips were assigned using an "equilibrium" procedure.
Equilibrium is attained when travelers cannot reduce their travel time by finding another zone-to-zone route. Equilibrium is achieved by an iterative, capacity-restrained assignment process (i.e.: when the vehicle capacity of a facility is reached by the model, speeds are reduced and trips are assigned to other streets and highways with available capacity and lower travel times). For the initial iteration of the assignment procedure, trips are loaded onto highway network links, using the minimum time path (i.e.: the streets and highways that provide the fastest travel times to a particular destination zone) based on initial travel times. Each subsequent iteration is preceded by an adjustment of the travel time or speed along the links to account for increasing congestion. In other words, vehicle trips are reassigned to alternate paths as congestion increases.

The Regional Model now includes a Heavy-Duty Truck Model (reference Chapter 7). The Regional Model incorporates heavy-duty truck trip tables into the highway assignment process. The Heavy-Duty Truck Model is integrated with the model software used to assign vehicle trips made by light-and-medium duty vehicles. As a result, for the first time, the traffic assignment process reflects the impact of truck traffic on traffic congestion. This integrated assignment process is performed using an "equilibrium assignments" for each of the four time periods.

The year 2000 highway assignment has added the transit buses, in passenger car equivalent (PCE), on highway links as preloaded volumes. This enables the model to account for the effects of transit buses on facilities of the transit routes.

Highway Assignment Summary

Table 8-2 presents an overview of the highway assignment statistics for each model time period and daily total. The Regional Transportation Model forecasts 340,330,000 VMT on an average weekday in Year 2000 within the model area for both light and medium duty vehicles. In addition, the Regional Model forecasts 22,431,000 VMT for heavy -duty vehicles in the expanded model area. The total for all vehicle types combined is 362,761,000 VMT.

Travel summaries have been compiled to report VMT, VHT, and vehicle hours of delay by county, facility type, and air basin. Table 8-3 presents comparisons of the SCAG-modeled VMT to VMT estimates from the HPMS by county and by air basin. The results for total VMT are very consistent. Specifically, the VMT results within the South Coast Air Basin are 4 percent below the corresponding results derived from HPMS data for all vehicles. Further, the VMT results from the Ventura County portion of the SCAG modeling area are within 7.8 percent of the corresponding HPMS statistical data.

Vehicle trip assignment is validated by comparing modeled total daily traffic volumes to actual Average Daily Traffic (ADT) counts or "ground counts", across a set of screenlines. A screenline is an imaginary line drawn across the highway network at strategic locations in the modeling area, which capture the total traffic flow across that line.

For the Year 2000 Model Validation, the highway assignments were validated using a screenline analysis performed on sixteen regional screenlines, including

Table 8-2

SUMMARY OF HIGHWAY ASSIGNMENT STATISTICS BY TIME PERIOD

Light and Medium Duty Vehicles	A.M. PEAK	P.M. PEAK	MIDDAY	NIGHT	TOTALS
Average Speed (Mile per Hour)	33.30	31.68	38.11	43.69	35.38
Vehicle Miles Traveled ('000)	70,873	111,404	106,102	51,951	340,330
Vehicle Hours Traveled ('000)	2,128	3,517	2,784	1,189	9,618
Vehicle Hours Delay ('000)	412.5	801.6	255.1	5.1	1,474
Heavy-Duty Vehicles					
Average Speed (Mile per Hour)	37.58	35.05	42.28	50.76	41.83
Vehicle Miles Traveled ('000)	2,980	4,893	7,720	6,838	22,431
Vehicle Hours Traveled ('000)	79.3	139.6	182.6	134.7	536.2
Vehicle Hours Delay ('000)	16.5	36.8	23.7	4.3	81.3
All Vehicles Combined					
Average Speed (Mile per Hour)	33.46	31.80	38.37	44.41	35.73
Vehicle Miles Traveled ('000)	73,853	116,297	113,822	58,789	362,761
Vehicle Hours Traveled ('000)	2,207	3,657	2,967	1,324	10,154
Vehicle Hours Delay ('000)	429	838	279	9	1,556

three new screenlines in developing areas. The screenline locations are depicted in Figure 8-1, and the results are presented in Table 8-4. Overall, the model volumes across all screenlines combined, differed by less than 3.5 percent from the same total of the "observed" or ground counts. These results are within tolerance levels considered acceptable for regional transportation modeling.

Description of the Transit Assignment Procedures

Transit trips from mode choice are aggregated by access mode and time period resulting in the following four trip tables:

Table 8-3

VMT COMPARISON BY AIR BASINS (THOUSANDS) SCAG MODEL VS. HPMS (MODELING AREA ONLY) YEAR 2000 WEEKDAY AVERAGE

		SCAB		MDAB		SCCAB		SSAB		TOTAL	
		L&M	HDV	L&M	HDV	L&M	HDV	L&M	HDV	L&M	HDV
LOS ANGELES	Model	180,678	11,730	5,744	293					186,422	12,023
	HPMS	191,862	11,292	6,492	443					198,354	11,735
ORANGE	Model	64,931	3,273							64,931	3,273
	HPMS	64,478	3,369							64,478	3,369
RIVERSIDE	Model	28,996	1,852					8,720	1,276	37,716	3,128
	HPMS	24,753	2,255					8,193	821	32,946	3,076
SAN BERNARDINO	Model	27,043	1,838	8,884	1,436					35,927	3,274
	HPMS	27,124	2,024	9,064	1,736					36,188	3,760
VENTURA	Model					15,334	733			15,334	733
	HPMS					16,081	880			16,081	880
TOTAL	**Model**	**301,648**	**18,693**	**14,628**	**1,729**	**15,334**	**733**	**8,720**	**1,276**	**340,330**	**22,431**
	HPMS	**308,217**	**18,940**	**15,556**	**2,179**	**16,081**	**880**	**8,193**	**821**	**348,047**	**22,820**
	Ratio	**0.979**	**0.987**	**0.940**	**0.793**	**0.954**	**0.833**	**1.064**	**1.555**	**0.978**	**0.983**

Note:
1. SCAB Riverside does not include RSA 50 (Banning)
2. L&M for Light and Medium Duty vehicles, HDV for Heavy-Duty Vehicles (Bus included).
3. SCAB=South Coast Air Basin, MDAB=Mojave Desert Air Basin, SCCAB=South Central Coast Air Basin, SSAB=Salton Sea Air Basin

Figure 8-1

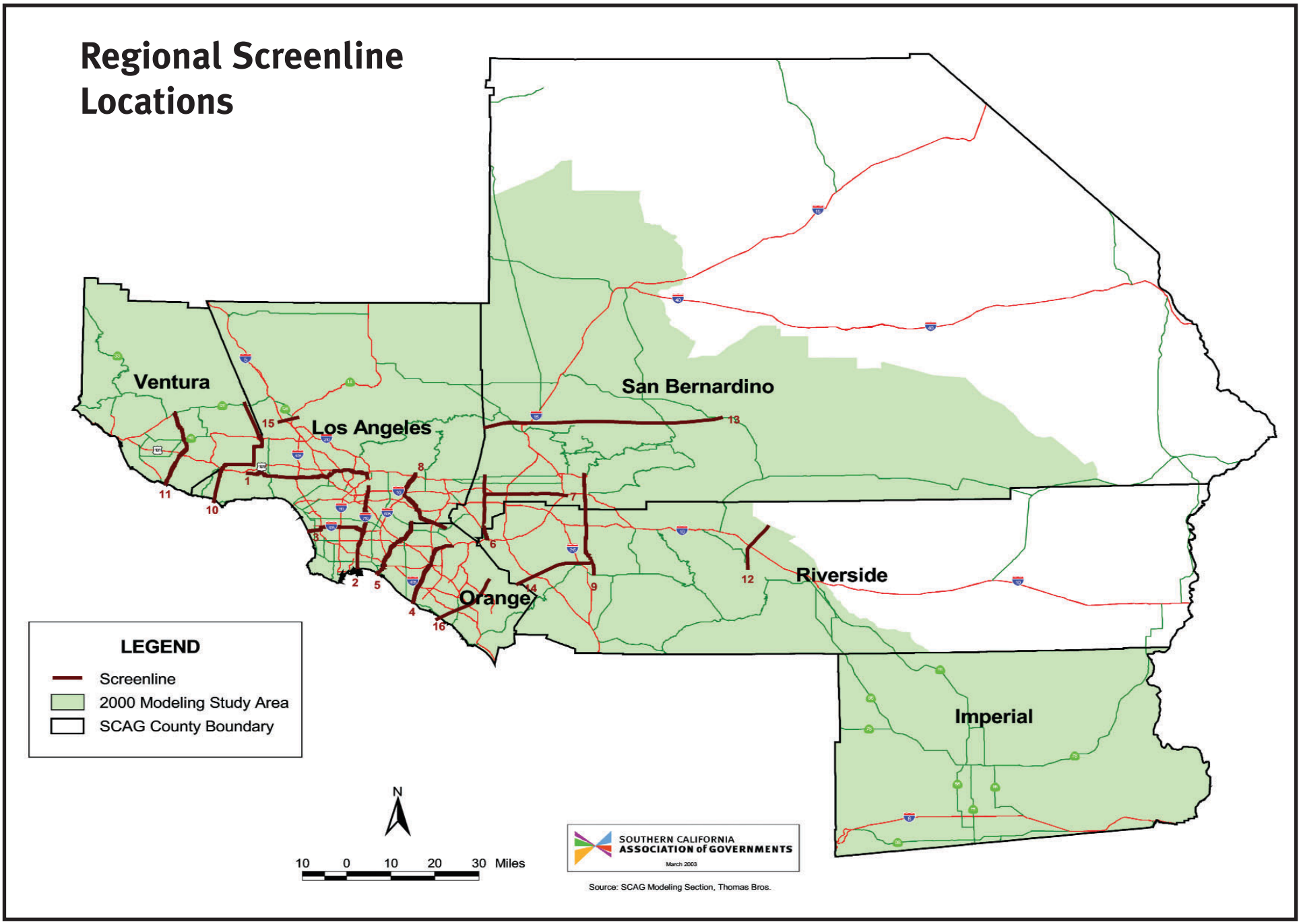

Regional Screenline Locations
Ventura
Los Angeles
San Bernardino
Riverside
Orange
Imperial
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
LEGEND
Screenline
2000 Modeling Study Area
SCAG County Boundary
N
10 0 10 20 30 Miles
SOUTHERN CALIFORNIA ASSOCIATION of GOVERNMENTS
March 2003
Source: SCAG Modeling Section, Thomas Bros.

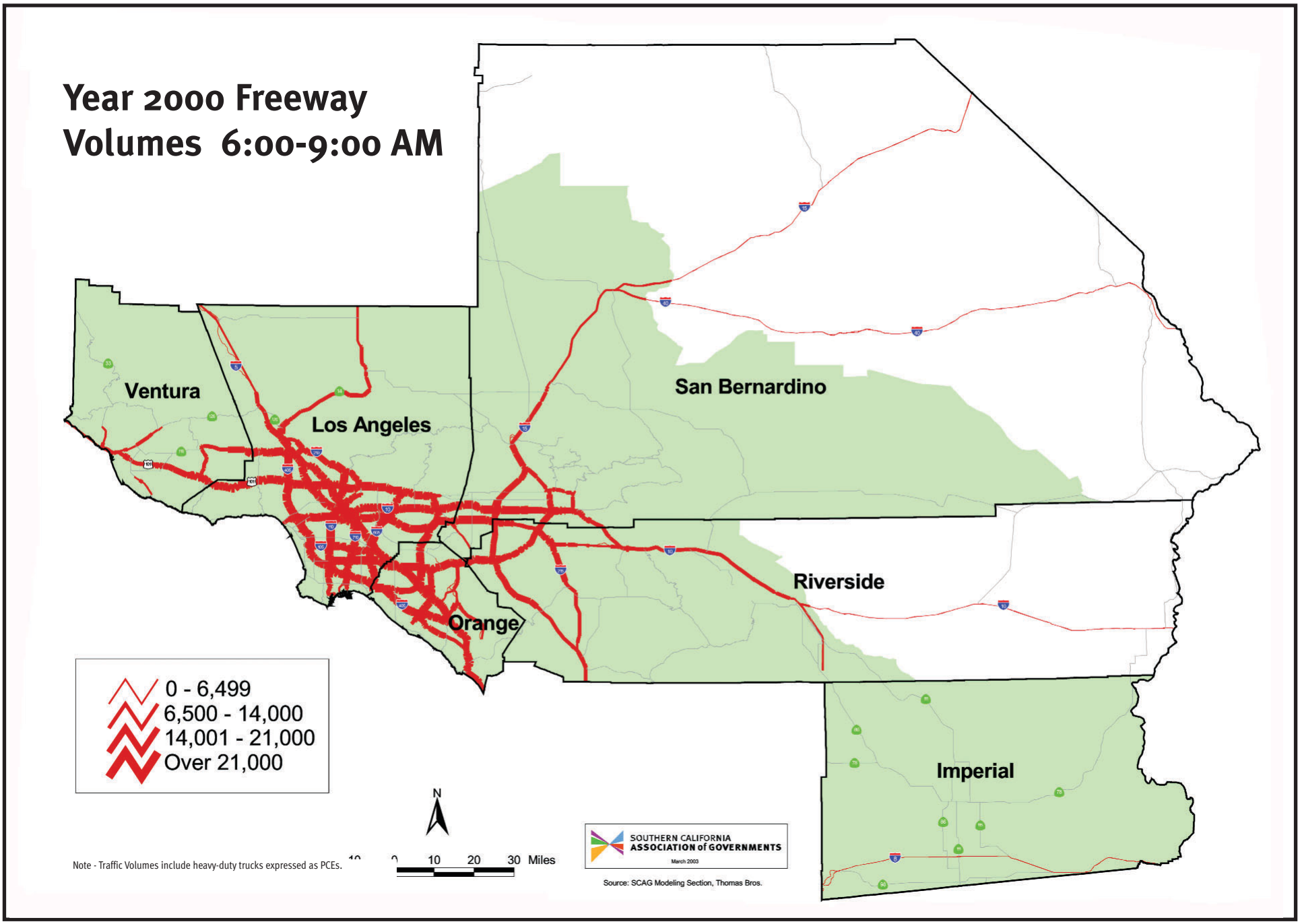
Table 8-4

SCREENLINE COMPARISON OF MODEL AWDT AND GROUND COUNTS

Screenline	Location County – Corridor	Direction	LIGHT & MEDIUM DUTY VEHICLES			HEAVY-DUTY VEHICLES		
			Model	Count	Ratio	Model	Count	Ratio
1	LA - S/O SR-134	EW	1,389,152	1,392,122	0.998	93,284	66,253	1.408
2	LA - LA River	NS	2,414,230	2,320,118	1.041	171,997	146,050	1.178
3	LA - S/O Century Freeway	EW	1,244,426	1,327,927	0.937	90,057	82,573	1.091
4	OR - Santa Ana River	NS	1,700,183	1,637,492	1.038	100,194	87,677	1.143
5	OR - LA County Line	NS	1,695,747	1,502,817	1.128	114,950	92,766	1.239
6	SB&RIV - E/O SR-83	NS	909,613	839,383	1.084	82,149	87,731	0.936
7	SB - S/O I-10 Corridor	EW	752,533	690,927	1.089	38,651	42,258	0.915
8	LA - San Gabriel Valley	NS	1,034,272	1,051,613	0.984	76,668	81,929	0.936
9	SB&RIV - Redlands/Moreno Vly	NS	393,235	422,822	0.930	30,277	27,055	1.119
10	VEN - LA County Line	NS	390,973	398,801	0.980	22,647	20,103	1.127
11	VEN - Camarillo	NS	216,020	191,446	1.128	15,535	11,292	1.376
12	RIV - Palm Springs	NS	126,455	130,412	0.970	19,050	15,520	1.227
13	SB - Victorvalley	EW	115,980	122,205	0.949	20,618	15,147	1.361
14	RIV - N/O SR-74	EW	189,280	151,956	1.246	14,615	18,022	0.811
15	LA - N/O Junction I-5&SR-14	EW	338,484	303,845	1.114	33,375	29,455	1.133
16	OR - S/O Junction I-5&I-405	EW	654,933	618,840	1.058	31,851	27,148	1.173
Total			**13,565,516**	**13,102,726**	**1.035**	**955,918**	**850,979**	**1.123**

Note:
1. AWDT = Average Weekday Daily Traffic, L&M=Light and Medium Duty Vehicle, HDV=Heavy-Duty Vehicle
2. Screenline 5 combines OCTA screenline 1 and 2, screenline 16 combines OCTA screenline 23, 24 and 25.
3. HDV Counts varies significantly by source. Data shown are based on VRPA counts for Freeways and 3% of arterial ADT.

Figure 8-2


Year 2000 Freeway
Volumes 6:00-9:00 AM
Ventura
Los Angeles
San Bernardino
Riverside
Orange
Imperial
0 - 6,499
6,500 - 14,000
14,001 - 21,000
Over 21,000
N
0 10 20 30 Miles
SOUTHERN CALIFORNIA
ASSOCIATION of GOVERNMENTS
March 2003
Note - Traffic Volumes include heavy-duty trucks expressed as PCEs.
Source: SCAG Modeling Section, Thomas Bros.

- Walk access, off-peak period
- Auto access, peak period
- Walk access, peak period
- Auto access, off-peak period

Each of the previous transit trip tables is assigned separately to the A.M. Transit Network. The resulting loaded transit network files are then aggregated to create a new loaded network containing total daily transit trips. The results of the transit assignment process are summarized below.

Transit Assignment Summary

The Year 2000 transit assignment loaded 2,196,000 unlinked passenger trips on the Year 2000 transit network. Table 8-5 presents the model estimated daily transit boardings for the four predominant transit mode categories, compared to actual transit boarding statistics for Year 2000. As Table 8-5 indicates the model estimates came within 3 percent of the actual regional total transit boardings. By mode category, the model came within 5 percent of the Metrolink boardings, 2 percent for the Metropolitan Transportation Authority (MTA) Bus boardings, and 3 percent for MTA Urban Rail boardings. The model's transit assignment underestimated total boardings for non-MTA local transit services (other local transit operators within the Region) by approximately 5 percent.

Table 8-5

DAILY TRANSIT BOARDINGS, 2000
Modeled vs. Actual

TRANSIT MODE	MODEL ESTIMATED BOARDINGS	ACTUAL BOARDINGS	RATIO, MODEL TO ACTUAL
Metrolink	32,600	31,000	1.05
Urban Rail	211,300	205,000	1.03
Blue Line	73,100	72,000	1.02
Green Line	23,700	27,500	0.86
Red Line	114,500	105,500	1.09
MTA Bus	1,241,600	1,215,300	1.02
Other Transit	710,500	677,000	1.05
Total Boardings	**2,196,000**	**2,128,300**	**1.03**

Notes:
1. Metrolink boardings for month of May, 2000.
2. Bus Boardings from MTA, Kumar, May, 2000
3. Metro Rail Boardings and other transit in LA co., MTA, Chessler, 2001.
4. Metro Rail Boardings, MTA, 2000. Green line ranged from 24,000 to 31,000.
5. Non LA co. transit. Added 3 percent population growth to 1997 data.